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AUTHOR Broadbent, William
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ABSTRACT

This document is an inventory of skills identified as necessary by professionals and technicians in the computer industry who supervise computer programming. It is intended as a mechanism whereby educators can compare that which they teach against what industry feels is relevant. Introductory material discusses the process of the occupational analyses, one of which resulted in this document; method employed; limitations; interpretation of industry data; and a narrative summary of industry data. The inventory of knowledge, skills, and attitudes necessary for successful participation in the field of computer programing follows. The items are divided into knowledge and skills and general attitudes. Listings of the items indicate weightings assigned by industry representatives; numbers of representatives and percentages are given. The various weightings are essential, important, desirable, and not necessary. The average or mean scores are also given. (YLB)

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AN INVENTORY OF SKILLS, KNOWLEDGE AND ATTITUDES FOR A CAREER IN COMPUTER PROGRAMMING

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Prepared by:
Statewide Technical Committee on Computer Programming

May 1988

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STATE BOARD FOR VOCATIONAL EDUCATION

AN INVENTORY OF SKILLS, KNOWLEDGE AND ATTITUDES FOR A CAREER IN COMPUTER PROGRAMMING

Produced by

Hawaii Statewide Committee on Computer Programming

May, 1988

State Board for Vocational Education

Preface

The Carl Perkins Act of 1984 requires that each state create technical committees to review the relevance of vocational curricula in terms of industry needs. This is a valid concern. In fact, were it not a federally mandated requirement, we would wish each of our teachers in Hawaii do this from time to time. We think that most of our professionals in the classrooms, laboratories and shops do this on an informal basis. This brief document is designed to help expedite and make overt the process. It is not a curriculum guide, but an inventory of skills identified as necessary by the technicians in industry. The document is a mechanism whereby each professional can reference that which he or she teaches against what industry feels is relevant. Use it to your advantage and to benefit those students enrolled in your program.

Gladys A. Brandt

Gladys A. Brandt
Chairperson of the State Board
for Vocational Education

Acknowledgments

The members of the Computer Programming Technical Committee were selected with the assistance of the Vocational Education Coordinating Advisory Council and the Computer Science staff of Leeward Community College. The members were nominated officially by the Chief Administrative Officer, Dr. Albert Simone.

Those selected and who served on the Statewide Computer Programming Committee were:

Jackie Barker
Senior Group Manager
Planning Research Corporation

Gordon Bruce
Director, Information Services
Queen's Medical Center

Desmond Byrne
Vice President, Administration
Computab, Inc.

Joseph Durocher
Vice President of Information Systems
Outrigger Hotels Hawaii

Evelyn Horiuchi
Computer Education Specialist
Department of Education

Barbara Hotta
Project Manager
Planning Resource Corporation

Warren Kuwahara
Information Management Operations
Hawaiian Telephone

Mary Naughton
Instructor, Computer Science
Leeward Community College

John Russell
Senior Systems Analyst
Hawaiian Electric

Stephen Scher
Programmer/Private Consultant
First Insurance

Belle Tugade
Project Manager
Planning Resource Corporation

Karen Wilson (ex officio)
Department Chair, Computer Science
Leeward Community College

Yukio Toyama, of the Occupational Development Section of the Department of Education, also provided materials and information regarding present computer applications in the business area. The canvass, data analyses, and technical preparation of this report was done by Dr. William Broadbent of the Office of the State Director for Vocational Education.

Introduction

The Carl Perkins Vocational Education Act of 1984, PL 98-524 had two major themes. These were "access to training for special populations" and "program improvement." This document, as others similar to it, is designed to satisfy the latter objective.

In Section 111 (d) it is mandated that:

> "Each State board in consultation with the State council shall establish a limited number of technical committees to advise the council and the board on the development of model curricula to address State labor market needs. Technical committees shall develop an inventory of skills that may be used by the State board to define state-of-the-art curricula."

Competent business persons find it worthwhile to re-examine their product or service provided from time to time for relevance and marketability. Those who do not adjust their products and services to meet changing times and consumer demand, do not stay in business long. The relevance and quality of what an economic enterprise produces is critical to the growth and survival of such organizations.

The same is true for professions such as medicine. Those medical doctors who fail to stay abreast of the newest drugs and medical techniques available will soon find themselves being eschewed by their colleagues and find their patients going elsewhere.

In education, albeit to a lesser extent, the necessity for staying current is essential. Educators need to make periodic reassessments as to whether that which they teach is relevant, up-to-date and at the cutting edge of present knowledge. This is particularly true for educators in the vocational/technical areas.

When teaching a subject that clearly has occupational implications, it is important to reference what one teaches against that which employers and those with established expertise in the field think is pertinent. Many times educators choose to teach things for reasons not understood by industry but which represent sound pedagogy. There is a system to learning which involves a rationale that is not always obvious immediately to those without training in the educational process. However, if there is little or no congruence between the knowledge, skills, and attitudes and what we teach, something may be amiss.

If the existing curriculum objectives are congruent with what industry thinks is important, in most cases the instructor should be reassured. However, if there is little or no congruence, the instructor may wish to reassess that which he or she teaches.

During the course of a series of interviews, conducted by the principal investigator with students and teachers, it became very apparent that the former needed to feel that what they were learning would be useful, even essential to obtaining and retaining a good job in a complex technical field. Students need to know and, in fact, want to know that the skills they are mastering are germane to the real world of work.*

Teachers do and should always be in essential control of that what they teach. However, when the goal is the acquisition of a skill having occupational implications, they should reference what they do against what industry thinks is important. That is what this brief report is all about.

This report deals with the requisite knowledge, skills, and attitudes of those involved in developing computer programs. It had initially been intended to include those skills involved with ongoing computer operations. However,

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* Note: This information was collected as part of another project.

the technical committee convinced the principal investigator that these two entry-level positions involved significantly different skill inventories. It was decided to concentrate on the programmer function. The information that follows was prepared by a committee having a broad range of interests in operational agencies and concerns in academia.

Purpose

In September of 1985, the State Board for Vocational Education in conformance with federal mandates and local inclinations, mandated that at least two technical committees be made operational each year to assess the entry-level employment requirements of a given occupational area. The technical committees were and are to update occupational information produced in earlier skill assessment surveys or provide information not available previously. Five areas have already been reviewed and reports of findings printed and distributed. These are "electronics," "automotive technology," "child care," "gerontology," and "community sentencing." Besides computer programming, one other is presently under study. The newest area presently being studied is "graphic arts."

Focus

Like our experience in electronics and child care, it became apparent that there are at least two distinct levels of entry into the technical field of data processing. An applicant for employment who enters at the first level cannot easily move from a position, say as a computer operator to a computer programmer, without regrouping a bit and providing himself or herself with additional training.

The jobs frequently associated with job entry at the "computer operations" point of entry would require effective participation in a relatively thorough high school program and/or some community college experience. The specific titles differ from firm to firm and agency to agency. However, the following occupational titles for entry at the computer operations level, which are frequently used, are as follows:

Data Entry Operator
Distribution Clerk
Data Control Clerk
Scheduler
Peripheral Equipment Operator
Computer Operator
Tape Library Attendant
Microfilm Operator
Documentation Clerk
Tape Librarian
Word Processing Operator

As previously mentioned, this study focused on the second skill level--computer programming.

The jobs frequently associated with job entry at the programming level would usually require at least the completion of an A.S. degree in computer science. Some firms prefer a degree from a four-year college. The following occupational titles for entry at the programming level are as follows:

Lead Data Operator
Lead Data Control Clerk
Lead Computer Operator
Lead Word Processor
Assistant Programmer
Programmer
Assistant Systems Analyst

In interviews with those concerned with personnel operations, it was reported that there may be leaks in the wall separating the computer operations and programming/quasi-managerial job entry positions which can be exploited by imaginative and able persons. However, for the general population the wall exists and is real.

Motivation, pre-entry preparation, and forbearance are the keys to success. As one goes higher in the occupational hierarchy, time constraints become greater, tension higher, and ambiguity more prevalent.

Methods Employed

A review of relevant materials available through the auspices of other states was facilitated by the Western Curriculum Coordinating Center.

The Computer Programming Technical Committee, with the help of resource staff members from the State Board for Vocational Education, then developed a "template" or "inventory" of knowledge, skills, and attitudes necessary for successful participation in the area which had been delimited--computer programming. Three versions of the inventory were developed and revised. Preliminary items for "computer operations" were deleted.

The third revision of the inventory was mailed to a representative sample of directors of data processing centers and persons in other industries having primary responsibility for computer programming and operations. Approximately 50 percent of the professionals and technicians surveyed returned comments and assessments of individual items during the month allotted for the process. The results are reported in this document which is succinct and designed to expedite easy perusal (refer to Table 1). The $\bar{X}$ symbol denotes the average or mean score. The data reported are descriptive and non-inferential in nature. However, they are easy to understand and interpret by anyone willing to take sufficient time to do so.

Limitations

Those from industry may not reflect the particular priorities of educators. It is to be remembered that their membership was selected from diverse private organizations and agencies. Often their individual priorities reflect the needs of their particular firm or agency. They may not reflect the specific skill requirements of novice generalists who have not

determined the particular area of concentration they wish to direct their professional efforts or the level of responsibility to which they may ultimately aspire. As previously mentioned, there may also be other things that educators may teach which may be prerequisite to other types of learning. The importance of these instructional components may not be self-evident to people directly involved in the employment market place.

Interpretation

The data computer programming, provided in Table 1, may be interpreted using the following guidelines:

Average score of 2.4 or above "essential"

Average score of 2.0 or above "important"

Average score of 1.5 or above "desirable"

Summary of Findings

The inventory, produced by the technical committee, is a valuable "finding" in itself. The terminology agreed upon is contemporary as of the publication date of this document and reflects what skills, knowledge, and attitudes this panel of experts felt was relevant for consideration for inclusion in any computer programming curriculum.

Of the 91 items identified by the committee in the "skills" and "knowledge" areas, 33 or 36.3 percent were basically deemed to be essential. The headings having the highest proportions of high ratings were "Basics of Computers" and "Basics of Programming." The three highest, with 2.7 average ratings, were "What is a Program," item 3.1; "What are Object Modules," item 1.9; and "Diskette," item 6.31. Refer to the following table.

Only 2 or 2.1 percent of the 91 "skills/knowledge" items was considered less than "desirable." There was no pattern here. Fifty-six or 6.5 percent of the items were deemed "important" or "desirable."

A careful review of the table is necessary for proper analysis.

In the area of attitudes, 7 or 63.6 percent of the attributes listed were considered "essential." The other 4 or 36.4 percent were considered either "important" or "desirable." The highest rated attributes with 2.6 ratings were "Motivation," item 8.3, and "Honesty," item 8.8. Once again, employers and/or supervisors value good attitudinal attributes in those who work with and for them.

Refer to Table for specific information.

Table 1

COMPUTER PROGRAMMING

Inventory of Skills, Knowledge, and Attitudes

I. Knowledge and Skills

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
1.0 Basics of Computers					
1.1 Terms and definitions	77	14	6	3	2.6
1.2 What is a computer	69	23	5	3	2.5
1.21 Central processing unit (CPU)	63	18	16	3	2.4
1.22 Monitor/ console	66	17	14	3	2.4
1.23 Memory	63	31	3	3	2.4
1.24 Peripherals	63	31	3	3	2.6
1.25 Keyboard layout	55	26	13	6	2.2
1.3 How does it work	55	26	13	6	2.2
1.4 Hardware vs. software	64	27	6	3	2.5
1.5 What is an operating system/control software	63	32	3	3	2.5
1.6 What is a compiler	63	20	11	6	2.4
1.7 What is an assembler	57	20	17	6	2.2
1.8 What are source modules	64	20	10	6	2.4

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
1.9 What are object modules	69	16	9	6	2.7
1.10 What is a load module	64	20	9	6	2.5
1.11 Micro/mini/ mainframe	46	23	28	3	2.1
1.12 Why use a computer	60	25	9	6	2.4
2.0 Basic Computer Abilities					
2.1 Ability to "block diagram" a computer system	28	24	42	6	1.4
2.2 Ability to correctly use terms and definitions in context	46	46	5	3	2.3
2.3 Ability to identify problems for solution by computer	35	63	3	3	2.2
2.4 Touch typing	17	34	34	15	2.0
3.0 Basics of Programming					
3.1 What is a program	80	14	3	3	2.7
3.11 System	72	29	3	6	2.6
3.12 Program	72	22	0	6	2.6
3.13 Subroutine	69	29	6	6	2.5
3.14 Procedure	65	17	12	6	2.4
3.15 Function	65	17	12	6	2.4

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
3.2 Objectives and characteristics of structured programming or "statements" techniques	37	43	14	6	2.1
3.3 Programming sections	57	37	3	3	2.4
3.31 Input	57	37	0	6	2.4
3.32 Calculation/manipulation	54	37	6	3	2.5
3.33 Output	51	43	3	3	2.4
3.4 Logic diagrams	31	34	29	6	1.9
3.5 Structure charts/top down design	23	40	31	6	1.8
3.6 Coding	62	29	3	6	2.5
3.7 Testing	54	40	3	3	2.6
3.71 Test plans	49	40	6	6	2.3
3.72 Unit/module test	54	34	6	6	2.0
3.73 System/integration test	46	42	6	6	2.3
3.8 Documentation	43	40	14	3	2.2
3.81 System	46	28	23	3	2.3
3.82 Program	46	31	17	6	2.3
3.83 User	49	34	14	3	2.3

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
4.0 Programming					
Specific language courses: BASIC, RPG, BAL, PASCAL, COBOL, FORTRAN, "C" language					
4.1 Calculations	46	39	9	6	2.4
4.2 Data definitions	54	37	3	6	2.3
4.3 Input	50	31	3	6	2.5
4.4 Output	57	34	3	6	2.4
4.5 Decision-making	47	44	3	6	2.3
4.6 Program flow control	45	40	9	6	2.3
4.7 File usage	49	49	0	6	2.4
4.71 Sequential	46	49	6	3	2.3
4.72 Index sequential	43	48	3	6	2.3
4.73 Other random	37	51	6	6	2.3
4.74 Key	37	51	6	6	2.3
4.8 Data selection	38	51	9	2	2.4
4.9 Data ordering/ sorting	40	43	14	3	2.2
4.10 Job control language	34	34	21	11	1.9

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
5.0 Programming Abilities					
5.1 Describe program logic	54	37	3	6	2.4
5.2 Develop structure chart	28	49	17	6	1.7
5.3 Code in language to clean compile with in-line documentation	46	39	9	6	2.6
5.4 Correct program	54	37	3	6	2.4
5.5 5.1 to 5.4 with moderately complex program	40	40	14	6	2.2
5.6 5.1 to 5.4 with complex program	28	40	23	9	1.9
5.7 Maintenance/ repair of other's programs	37	37	20	6	2.1
6.0 System Usage Concepts					
(Machine specific. Mc = micro only, Mf = mainframe only)					
6.1 How to 'start' the system	43	22	26	9	2.0
6.11 Microcomputer (Mc)	49	14	31	6	2.1

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
			N = 35 H%		
6.12 Batch job (Mf)	23	29	39	9	1.6
6.13 Tele-processing session (Mf)	14	28	52	6	1.5
6.2 Diskette usage (Mc)	43	25	29	3	2.1
6.3 Concept of storage media	54	29	14	3	2.2
6.31 Diskette	54	25	17	3	2.7
6.32 Hard disk	54	34	9	3	2.1
6.33 Magnetic tape	49	31	14	6	2.2
6.34 Removable packs	43	25	25	6	2.1
6.4 Program execution	37	43	17	3	2.1
6.41 Job control language	34	31	23	12	1.9
6.42 Batch files	29	46	19	6	2.0
6.43 Linkage editors	29	37	25	9	1.9
6.5 Back-ups	46	29	14	11	2.3
6.51 System	46	32	11	11	2.3

Inventory of Skills, Knowledge, and Attitudes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
6.52 Programs	20	31	40	9	1.6
6.53 Files	52	29	17	6	2.2
6.6 Utilities/ sorting data	31	43	20	6	2.0
6.7 How to 'stop' the system	34	38	14	14	2.2
6.8 File commands	31	38	20	11	1.8
6.9 Loader commands	22	38	29	11	2.3
7.0 System Usage					
7.1 System boot/ start	31	29	20	20	1.7
7.2 Program execution	34	34	15	17	1.8
7.3 System shut-down	31	23	26	20	1.6
7.4 Ability to use system utilities	20	54	15	11	1.8
7.5 Networking and communications	11	26	57	6	1.4

Inventory of Skills, Knowledge, and Attitudes

Attitudinal Formation

II. Attitudinal and Other Desirable Personal Attributes

Weighting:	(3) Essential	(2) Important	(1) Desirable	(0) Not Necessary	$\bar{X}$
		N = 35	H%		
8.0 Ability to assume responsibility	51	40	9	0	2.4
8.1 Dependability	57	40	3	0	2.5
8.2 Adaptability	48	46	6	0	2.4
8.3 Motivation	63	24	6	0	2.6
8.4 Willingness to work with others	51	43	6	0	2.5
8.5 Willingness to work long hours	23	40	34	1	2.1
8.6 Safety/security orientation	23	54	23	0	2.0
8.7 Quality consciousness	51	46	3	1	1.6
8.8 Honesty	63	34	3	0	2.6
8.9 Loyalty	42	46	12	0	2.3
8.10 Self-starter	51	29	20	0	1.8
8.11 Positive self-concept	57	31	12	0	2.5